DISCUSSION OF THE AMENDMENTS

Claim 1 was previously cancelled.

Claims 2-15 are cancelled without prejudice or disclaimer.

Claims 16-26 are new.

Upon entry of the Amendment, claims 16-26 will be active.

Claims 16-26 are supported by the claims as previously presented and by the specification as originally filed.

No new matter has been added.

Application No. 10/615,794
Amendment dated September 12, 2006
Reply to Office Action of July 13, 2006

Docket No.: YOR920030059US1
(20140-00302-US)

REMARKS/ARGUMENTS

In view of the above amendment, applicant believes the pending application is in condition for allowance.

The present disclosure relates to a method of operating a plating bath such that the number of voids in the plated metal is minimized. The method involves first plating a metal on a substrate in a plating bath containing an accelerator. Then an accelerator breakdown product concentration and remaining accelerator concentration is measured along with the number of voids in the plated metal. This process is repeated and the relative concentration of accelerator breakdown product to accelerator concentration (VFM ratio) is then determined as a function of the number of voids in the plated metal.

The plating bath is then operated at a VFM ratio below the highest VFM ratio at which no voids are observed. The results of this process are illustrated in Fig. 4 of the specification where the number of voids as a function of the VFM ratio is plotted. The method provides for a convenient method of operating a plating bath while minimizing the number of metal voids. Applicants have found that the relative concentration of accelerator breakdown product to accelerator determines the number of metal voids in a plating process. This process provides for an improvement over traditional methods which seek to improve plating operations by controlling a single variable which is typically the absolute concentration of by-product contaminants in the plating bath. This allows for more efficient and economical use of plating bath accelerants.

The cited references do not teach or suggest the disclosed method nor is there any motivation to modify the cited references.

The rejection of the claims under 35 U.S.C. § 103(a) over the combination of Seita (U.S. 6,881,319), Chalyt (U.S. 6,749,739) and Blachier (U.S. 6,569,307) is respectfully traversed.

Seita describes a method for controlling an electrolytic copper plating solution. The method involves addition of a thiol-reactive compound to the plating solution to maintain the decomposition products of a specific sulfur-containing compound which is added for the purpose of increasing the deposition rate in the vicinity of the bottom of a micro via hole (column 2, lines 15-56). The method includes maintaining a specific maximum allowable concentration for the decomposition product (0.15 μmol/L) and adding thiol-reactive compound (1×10^{-4} to 1×10^{-1} mol/L) to maintain the bath below the maximum allowable decomposition product concentration (column 5, lines 64-67 and column 7, lines 4-15). Overall, Seita describes controlling the decomposition product to an absolute concentration using a chemical additive (a thiol-reative compound).

This is in direct contrast with the present disclosure which maintains a relative concentration of accelerator breakdown product to accelerator and which uses a bleed and feed process to maintain this relative concentration.

Chalyt describes a method of qualitatively monitoring the breakdown products of a suppressor compound in a plating bath. The suppressor compounds are high molecular weight polyalkylene glycol compounds. The breakdown products are low molecular weight glycols which are less efficient suppressors and therefore undesirable. The method involves measuring the endpoint volume fraction of a plating bath at a -0.400 V potential and a -0.225 V potential. It was determined that the endpoint volume fraction of a low molecular weight glycol at -0.400 V is much higher than a high molecular weight glycol. Using this property, a plating bath can be monitored to qualitatively monitor (by observing an increase in end point volume) the increase in undersirable low molecular glycols which are the decomposition product of desirable high molecular weight glycols.

The method does not provide a quantitative analysis of the contaminants as the Office has suggested. The method simply observes an increase in endpoint volume fraction for the low molecular weight glycol contaminant at -0.400 V relative to the volume fraction at -0.225 (see Fig. 1). As illustrated in Fig. 1, Chalyt found that high molecular weight glycols do not have a

difference in endpoint volume fraction at -0.225 versus -0.400 V. Because low molecular weight glycols show at large difference in endpoint volume fraction at these two voltages, it offers a convenient method of monitoring the buildup of low molecular weight glycols in the plating bath. This method does not quantitatively measure glycol concentrations as suggest by the Office. This non-quantitative approach is certainly not analogous to the disclose method which quantitatively measures both accelerant and a break down product of the accelerant (see column 7, lines 25-47 of Chalyt).

This technique is not quantitative as suggested by the Office but merely indicates when some level of build up of decomposition products has occurred.

Accordingly, this is simply a qualitative tool not a quantitative tool. Overall, Chalyt is only cumulative to Seita in that Chalyt only describes the general concept that breakdown contaminants may be deleterious to some aspects of the performance of a plating bath and these contaminants may need to be minimized. Chalyt only describes that glycol type suppressors can break down and thus affect the suppressing effect of the glycols. Chylat provides no specific teaching or suggestion for other types of breakdown contaminants or how they may affect other aspects of the performance of a plating bath or how the contaminants may be controlled. Accordingly, Chalyt does not teach or suggest the limitations missing from Seita.

Blachier generically describes a method for operating a plating bath by correlating plating bath performance properties with contaminants. Blachier lists a few performance properties that may be investigated but provides no specific guidance as to how to determine which interactions are critical out of the numerous possibilities. As such, Blanchier is only cumulative to Seita.

Overall, a combination of the three cited references generically describe that contaminants in a plating bath can affect plating performance. Seita specifically describes adding a thio-reactive compound to reduce the decomposition product of a specific sulfur-containing compound which can affect plating performance. Chalyt specifically, describes

qualitative monitoring the build up of low molecular weight glycol contaminants in a plating bath.

Applicants acknowledge the concept of reducing contaminants from a plating bath to improve plating performance is not new. However, how the contaminants affect plating bath performance and how the contaminants are monitored and reduced can vary greatly. The specific method of operating the plating bath can vary greatly, and accordingly, a specific method would not necessarily be obvious.

The Office has concluded that the concept of reducing contaminants from a plating bath to improve plating performance is obvious; and therefore, all specific methods are obvious to try. However, how one achieves these goals are not necessarily obvious. The disclosed method is not taught or suggested by the cited references. The Office has concluded that it would be obvious to try to vary all parameters or try each of numerous possible choices until one possibly arrived at a successful result, where the prior art gave no direction as to which of many possible choices is likely to be successful. The references simply provide an insufficient teaching or suggestion to reasonably arrive at the disclosed method since the references provide only general guidance (MPEP 2145(X)(B)). Accordingly, the disclosed method would not have been obvious over the references and Applicants respectfully request that the Examiner withdraw the rejection.

In addition, the Office has suggested modifying Seita in view of Chalyt and Blachier.

As noted above, Seita requires addition of a thio-reactive compound to reduce the amount of contaminant to a specific level. This step is central to the process described in Seita, and accordingly, there would be no motivation to eliminate this step. While addition of a thio-reactive compound is not excluded by the disclosed method is it not necessarily required. Modification of Seita by eliminating this required step would render the method inoperable for its intended purpose. The purpose for adding the thio-reactive compound is to maintain the contaminant level below a fixed concentration. The present disclosure has no fixed contaminant level requirement, but rather has a maximum ratio (only VFM threshold ratio) based on the

accelerator breakdown product and accelerator concentration. Because the proposed modification in view of the other cited references would render the prior art unsatisfactory for its intended purpose, the disclosed method would not have been obvious over the cited references. Therefore, Applicants respectfully request that the Office withdrawn the rejection (MPEP 2143.01(V)).

In addition, Applicants note that in order to establish a case of obviousness, the cited reference must teach or suggest all of the limitations of the disclosed method. None of the cited reference teach or suggest relating the ratio of an accelerator breakdown product concentration and an accelerator concentration in a plating bath to the number of voids in a plated substrate. The Office concluded that Chalyt suggests this limitation; however, as noted above Chalyt is a qualitative method and only gives information of a build up of low molecular weight glycols. Chalyt does not quantitatively determine the concentration ratios of a plating bath additive and a breakdown product. The method described in Chalyt simply provides an indication that low molecular weight glycols have increased in the plating bath. This provides no teaching or suggest for the limitation of the disclosed method.

Applicants also note that obviousness must be based on the prior art available at the time the invention was made. A determination of obviousness can not be made in light of the Applicants own disclosure (MPEP 2145(X)(A)).

Applicants specific disclosed approach would not be obvious based only on the general concept that contaminants are undesirable in a plating bath and should be controlled. There are many possible contaminants that can form in a plating bath and the contaminant can affect plating performance in many possible ways. In addition, there are many different approaches for determining which contaminants affect which properties and many different approaches for dealing with the contaminants. A description of a specific approach as described in Seita and Chalyt or a general method as described in Blachier does not make the specific approach disclosed by Applicants obvious nor can the disclosure be obvious in light of the Applicants own disclosure. Accordingly, Applicants respectfully request that the Office withdrawn the rejection.

Finally, Applicants note that the disclosed method is an improvement over existing technology. The cited methods involve monitoring a single variable which is the contaminant level. The cited methods seek to limit this contaminant at a fixed level by adding more chemicals to the plating bath or by diluting the contaminant in the plating bath. The disclosed method does not require extra chemicals in the plating bath and does not require a fixed minimum contaminant level in the bath, and therefore, a less rigorous control of the plating bath chemistry is required. The method provides flexibility in the plating process with regard to plating bath chemistry as it relates to the substrate being plated. Because the disclosed method is an improvement over existing methods, the disclose method would not be obvious over the cited references (MPEP 2144.09).

In view of the above, consideration and allowance are, therefore, respectfully solicited.

In the event the Examiner believes an interview might serve to advance the prosecution of this application in any way, the undersigned attorney is available at the telephone number noted below.

The Director is hereby authorized to charge any fees, or credit any overpayment, associated with this communication, including any extension fees, to CBLH Deposit Account No. 50-0510, under Order No. 20140-00302-US from which the undersigned is authorized to draw.

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Respectfully submitted,

By 

Donald K. Drummond, Ph.D.
Registration No.: 52,834
CONNOLLY BOVE LODGE & HUTZ LLP
1990 M Street, N.W., Suite 800
Washington, DC 20036
(202) 331-7111
(202) 293-6229 (Fax)
Attorney for Applicant